NUMERICAL TAXONOMIC TECHNIQUES CONFIRM THE VALIDITY OF TWO GENERA IN TRACHINIDAE

by

Flegra BENTIVEGNA and Graziano FIORITO (1)

ABSTRACT. – From a comparative study of the external morphology and osteological aspects of *T. draco, T. araneus, T. radiatus* and *E. vipera* we were able to construct phylogenetic trees which confirm the supposed dichotomy in the family of Trachinidae.
The evolution of this taxon is discussed.

RÉSUMÉ. – La comparaison des caractéristiques morphologiques et ostéologiques entre *T. draco, T. araneus, T. radiatus* et *E. vipera*, a permis d'obtenir des arbres phylogénétiques qui confirment la réelle dichotomie de la famille des Trachinidae.

Trachinids or spider fishes are Teleostei of the Perciformes order, which are able to inflict painful pricks with their opercular and dorsal spurs.

Mediterranean Trachinidae were traditionally included in the genus *Trachinus* Linnaeus (1758). Now Trachinidae are held to consist of two genera : *Trachinus* represented by three species *T. draco, T. araneus* and *T. radiatus*, and the genus *Echiichthys* represented by *E. vipera*. This distinction was first proposed by Bleeker in 1861 and was ignored, and only recently it was reconfirmed (Tortonese, 1975 ; Wheeler, 1973). An osteological investigation supported the dichotomy (Bentivegna, 1982). Here we report data on the external morphology and osteological characters (skull, urophore complex) of the four species of Mediterranean Trachinidae. A description of interspecies variability was based on these characters. By adopting numerical taxonomic techniques we were able to establish the degree of affinity between the four species of Trachinidae and confirm the dichotomy between genus *Trachinus* and genus *Echiichthys.*

As material we used several specimens of the four species mentioned above ; fresh specimens were obtained from the Bay of Naples and Adriatic Sea and preserved specimens from the Museum of the Stazione Zoologica, Naples and the Museum national d'Histoire Naturelle, Paris. The bones were prepared by the usual techniques of cleaning, boiling, fixing etc.

The different phenotypic aspects of each species are numbered and ordered in tables. This numbering has no quantitative meaning but represents a fixed phenotypical aspect. Equal numbers mean similar phenotypical aspects in two species ; different numbers denote different phenotypes. These numerical expressions are compared without taking the order and value of each number into account. Each difference found is considered as a unit and the total amount of the differences, denotes the affinity degree between species. The degree of affinity is divided by the total number of phenotypical aspects thereby giving the degree of similarity between species expresses as percent. All these values ordered in a matrix, enable us

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(1) Stazione Zoologica di Napoli, Villa Comunale, 80121 Napoli.

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to construct cladogramms showing interspecies variability. We used the classic matrix method (Fitch & Margoliash, 1967) to construct phylogenetic trees, without using the difference matrix. In fact, methods using the difference matrix alone often fail to give the correct pattern of tree branching when the different species evolve at different rates (Sokal & Sneath, 1963 ; Farris, 1972 ; Klotz *et al.*, 1979). Following Klotz and Blanken (1981), we used the « present day ancestor method », which adopts a present day sequence as a temporary ancestor to determine the correct tree topology, thus the ancestral sequence was not required. This is the first time this method has been used as a numerical taxonomic technique based on morphological data.

Tab. I. – Data and codes on external morphology.

T. draco		*T. araneus*		*T. radiatus*		*E. vipera*	
Fore-upper border of the eye-socket with two spines	1	Fore-upper border of the eye-socket with two spines	1	Fore-upper border of the eye-socket with two spines	1	Fore-upper border of the eye-socket without spines	2
Cheeks with scales	3	Cheecks with scales	3	Cheecks with scales	3	Cheeks without scales	4
Pectoral fins : trapezoidal	5	Pectoral fins : trapezoidal	5	Pectoral fins : trapezoidal	5	Pectoral fins : rounded	6
Lateral line with 80 scales	7	Lateral line with 70 scales	8	Lateral line with 70 scales	8	Lateral line with 60 scales	9
Dorsal rays: V-VII	10	Dorsal rays: VII	11	Dorsal rays: VII	11	Dorsal rays: V-VII	10
Dorsal rays: 29-32	12	Dorsal rays: 26-29	13	Dorsal rays: 24-27	14	Dorsal rays: 21-24	15
Anal rays: II	16	Anal rays: II	16	Anal rays: II	16	Anal rays: I	17
Anal rays: 28-34	18	Anal rays: 29-31	19	Anal rays: 26-29	20	Anal rays: 24-26	21
Max. length: 40 cm	22	Max. length: 40 cm	22	Max. length: 42 cm	23	Max length: 14 cm	24
Caudal fin: slightly concave	25	Caudal fin: slightly concave	25	Caudal fin: straight	26	Caudal fin: straight	26
Dorsal fin: partly black	27	Dorsal fin: partly black	27	Dorsal fin: partly black	27	Dorsal fin: black	28
Hips with obliqual spots	29	Hips with variable spots	30	Hips with annular spots	31	Hips with longitudinal spots	32
Head with brown spots	33	Head with several blacks dots	34	Head with black spots	35	Head with dark spots	36
Colour pattern: greenish	37	Colour pattern: yellowish	38	Colour pattern: yellowish	38	Colour pattern: yellowish	38

The comparison of the external morphological aspects gave the data of table I and the calculus of the difference matrix (Fig. 2a). The osteological aspects considered are: teeth (distribution and morphology), pre-opercular bones, interorbital bones, suborbital bones and urophore complex. The comparison showed that only teeth (tab. II) and urophore complex (Fig. 1 ; tab. III) can be used for taxonomic analysis. Other data did not allowed a good statistical valuation. Fig. 2b and 2c gives the difference matrix derived from the comparison of teeth and urophore complex between the four species considered. The elaboration regarding the urophore complex gives the affinity degree between two genera. It is for the homoge-

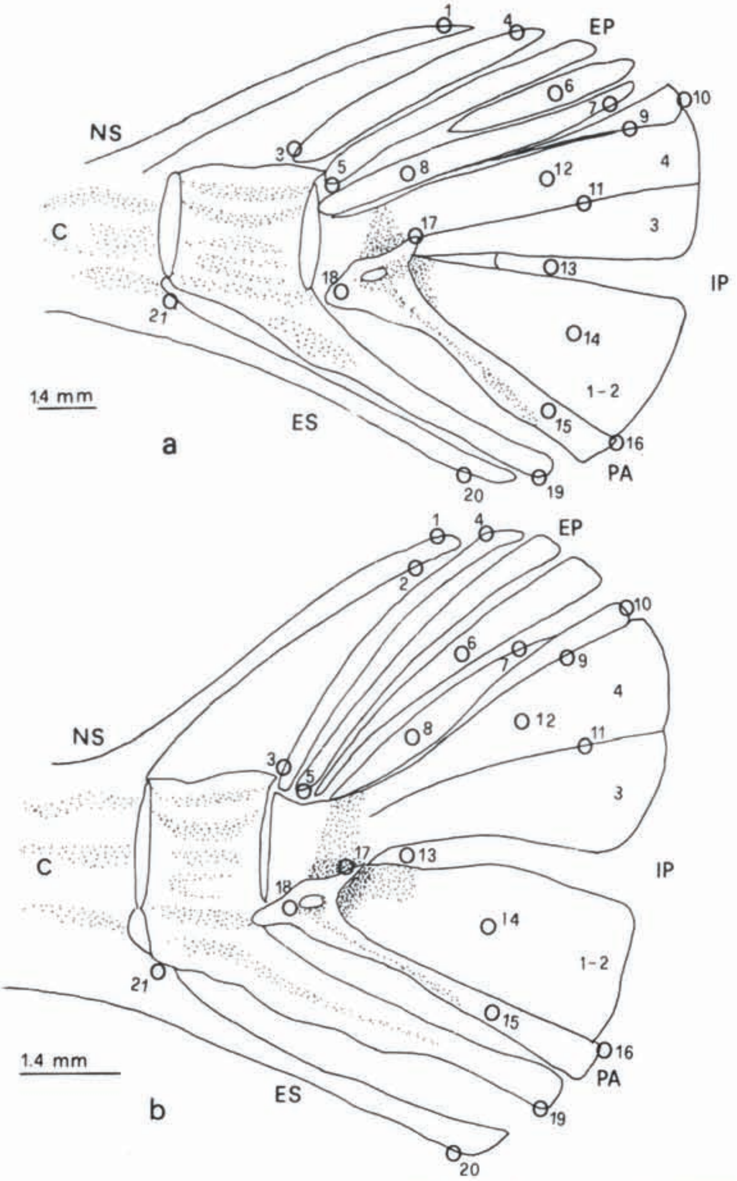

Fig. 1. – Comparison between urophore complex of *Trachinus draco* (a) and *Echiichthys vipera* (b). Abbreviations: IP hypurals, PA parhypurals, NS Neurospine, ES hematospine, C centre of the vertebrae.

neity in the genus *Trachinus*. From the different matrices shown in Fig. 2 we have drawn the corresponding cladogramms. Fig. 3a shows the close relation between *T. araneus* and *T. radiatus* and their equidistance from *E. vipera*. Furthermore, *T. draco* is more related to *E. vipera* than to the other species of the same genus. Fig. 4 shows a spatial projection of the branches. It can be seen that all branches of a)

	A	B	C	D
A	0	7	9	13
B	50	0	6	13
C	64	42	0	12
D	92	92	85	0

b)

	A	B	C	D
A	0	6	7	4
B	75	0	7	7
C	87	87	0	7
D	50	87	87	0

c)

	A	B	C	D
A	0	0	0	19
B	0	0	0	19
C	0	0	0	19
D	76	76	76	0

Fig. 2. – Differences matrices - a) external morphology ; b) teeth ; c) **urophore complex. Upper half of each matrix lists the degree of affinity and lower half lists percent of mutational divergence** i.e. the similarity degree. A : *T. draco* ; B : *T. araneus* ; C : *T. radiatus* ; D : *E. vipera*.

Tab. II. – Data on teeth.

T. draco		***T. araneus***		***T. radiatus***		***E. vipera***	
Premaxillae							
2 or 3 rows	1	4 or 5 rows	2	5 rows	3	irregular rows	4
caniniform	5	recurved on inner	6	recurved on inner	7	tiny	8
Maxilla							
more rows	9	2 or 3 rows	10	2 rows	11	more rows	9
Jaw							
2 or 3 rows	12	2 or 3 rows	12	5 rows	13	2 rows	14
caniniform	15	recurved on inner	16	conical recurved	17	unequal	18
Vomer							
unequal	19	regular	20	small	21	unequal	19
on the ant.part	22	on the ant.part	22	on the ant.part	22	on the ant.part	22
Palatine							
unequal	23	regular	24	small	25	unequal	23

the genus *Trachinus* are on the same plane opposite to that of *Echiichthys*. A similar condition emerges from the data derived from the external morphology. The angle of intersection of the planes of the genera *Trachinus* and *Echiichthys* is above 90°. The measurement of this alpha angle enables us to compare phylogenetic trees derived by different data and to measure the divergence between the taxa. Generally an alpha angle less than 90° can be quoted to a interspecies variability. Data obtained from the urophore complex show that the divergence degree between the genus *Trachinus* and the genus *Echiichthys* is 178° (Fig. 4), and is above the value indicating interspecies variability.

Calculus of numerical taxonomy supported the presumed dichotomy in the Trachinidae. The comparison between the divergence degrees calculated by the cladogramms shows homogeneity among the three species of the genus *Trachinus*, caused by the interspecies variability. Therefore, the divergence degrees measured between *T. draco*, *T. araneus* and *T. radiatus* and between the first two and *E. vipera*, are more than 90°. It is unlikely that the variability is due to the interspecies variability. This type of approach could also be adopted in investigations on the rate of evolution of each species. However, knowledge of the paleogenetic age and of the number of neutral and back mutations is required for such studies. This evaluation is today impossible due to the lack of molecular data of this taxon. The rate of evolution considered here, is derived from the morphological distance. The close relation between *T. araneus* and *T. radiatus* could be due to a recent origin of the taxa. The affinities found in teeth (for example) suggest that as *T. draco* and *E. vipera* have common ancestral characters, the present divergence is the result of a different evolutionary rate.

Study of the ecological and behavioural aspects for each species together with data derived from molecular evolution is necessary to explain the evolutive strategies of the taxon.

Tab. III. – Data on urophore complex.

	Trachinus		*Echiichthys*	
Neurospine	Acute	1	Rounded	2
	Does not rely on the I epiural	3	It relies on the I epiural	4
Epiural 1	Join on the 2nd vertebra	5	Join on the 1st vertebra	6
	Stout	7	Thin	8
	Rounded	9	Rounded	9
Epiural 2	Join on the 2nd vertebra	10	Join on the 1st vertebra	11
Epiural 3	Small	12	Large	13
Stegural	Quadrangular edge	14	Acute edge	15
	Large	16	Small	17
Hypural minime	Sutured to hyp. 4	18	Sutured to hyp. 4	18
	Ending with hyp. 4	19	Not ending with hyp. 4	20
Hypurals 3-4	Sutured	21	Sutured	21
	Large	22	Very large	23
Hypural diastema	Marked	24	Very marked	25
Hypurals 1-2	Melted	26	Melted	26
Parhypurals	Squat	27	Thin	28
	Ending with hypurals 1-2	29	Not ending with hypurals 1-2	30
	Spinous process-rounded on the back	31	Spinous process-acute on the back	32
	Spinous process-ending near the suture of hyp. 3-4	33	Spinous process-ending near hyp. diastema	34
	Spinous process- anteriorly short	35	Spinous process- anteriorly long	36
	Spinous process-does not rely on the vertebra	37	Spinous process-relies on the 2nd vertebra	38
Hematospine 2	Rounded	39	Flattened	40
Hematospine 3	Thin	41	Thin	41
	Rounded	42	Flattened	43
	Distant to the 2nd vertebra	44	Near to the 2 nd vertebra	45

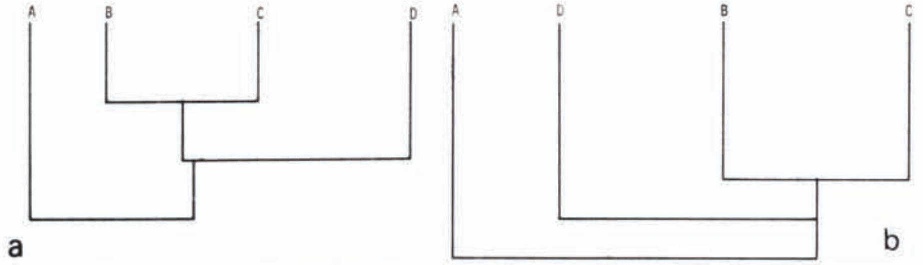

Fig. 3. – Cladogramms constructed by the difference matrices regarding external morphology (a) and teeth (b).

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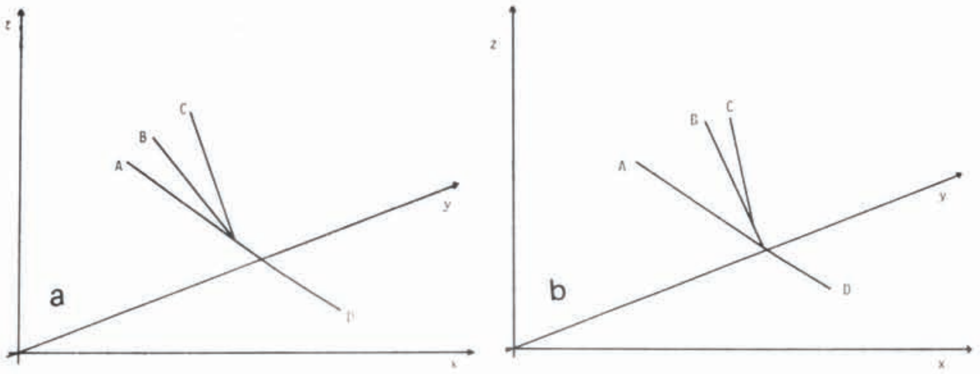

Fig. 4. – Tri-dimensional projection of the phylogenetic branches by external morphology (a) and teeth (b). The alpha angle is constructed by the intersections of the planes.

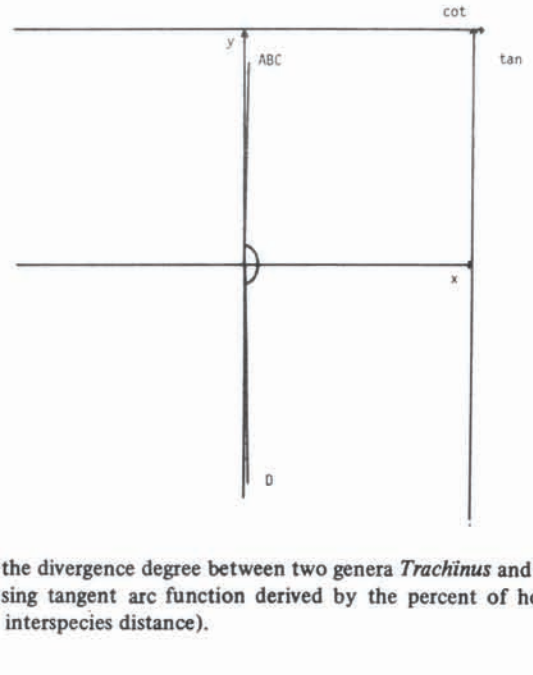

Fig. 5. – Calculus of the divergence degree between two genera *Trachinus* and *Echiichthys*. This value is computed using tangent arc function derived by the percent of homogeneity (total amount of matrix by interspecies distance).